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Washington, DC 20548

November 20, 2012

The Honorable John D. Rockefeller IV
Chairman
The Honorable Kay Bailey Hutchison
Ranking Member
Committee on Commerce, Science, and Transportation
United States Senate

The Honorable Fred Upton
Chairman
The Honorable Henry A. Waxman
Ranking Member
Committee on Energy and Commerce
House of Representatives

Subject: *Spectrum Management: FCC's Licensing Approach in the 11, 18, and 23 Gigahertz Bands Currently Supports Spectrum Availability and Efficiency*

Radio-frequency spectrum is a natural resource that is used to provide an array of wireless communications services critical to the U.S. economy and a variety of government functions, such as scientific research, national defense, homeland security, and other vital public safety activities. As new spectrum-dependent technologies and services are brought to market and government users develop new mission needs, the demand for spectrum continues to increase and additional capacity will be needed to accommodate future growth that cannot be addressed through more efficient use of wireless technologies. A primary driver of the increased demand for spectrum has been the significant growth in commercial wireless broadband services, including third and fourth generation technologies that are increasingly used with smart phones and tablet computers.[1] To accommodate this growth, common carriers, such as cellular phone companies and other telecommunications firms providing communication services to the public, often rely on wireless methods, such as *fixed point-to-point microwave service*, to transmit data.[2] Fixed point-to-point microwave service refers to a radio communication between two fixed points, such as between two stationary cell phone towers. These connections, known as links, are used for a variety of purposes, including connecting cellular sites to the telephone network and relaying television signals.

The Federal Communications Commission (FCC)—an independent agency that regulates spectrum use for commercial and other nonfederal users—manages spectrum through

[1]Wireless broadband comprises both fixed and mobile wireless communication services. *Fixed-wireless broadband* refers to stationary wireless devices or systems that provide high-speed Internet access from a fixed location. *Mobile broadband* refers to wireless high-speed Internet access through a portable device, such as a cell phone.
[2]According to FCC, a microwave frequency is any frequency at or above 890 megahertz (MHz).

allocation and *assignment*.[3] Allocation involves designating *bands* of spectrum for specific types of services or classes of users, such as for commercial or government use.[4] Assignment provides a license to a specific entity, such as a wireless company, to use a specific portion of spectrum. To facilitate the use of point-to-point communications, FCC has allocated spectrum for microwave connections in the 11, 18, and 23 gigahertz (GHz) (*common carrier*) bands, as well as in a number of other microwave spectrum bands.[5] In recent years, use of microwave links has increased significantly, particularly as a cost-effective alternative to traditional wireline technologies, such as fiber optics. Given the increasing demand for and importance of these types of links, a few industry stakeholders have expressed concern about the availability of additional spectrum and whether FCC's policies reflect the value of this spectrum.

In the Middle Class Tax Relief and Job Creation Act of 2012, Congress directed us to examine FCC's licensing approach in the 11, 18, and 23 GHz bands.[6] Consequently, we examined (1) the steps FCC has taken to ensure availability of common carrier licenses in the 11, 18, and 23 GHz bands and the extent to which these steps provide incentives for efficient use of this spectrum, and (2) how alternative approaches to assigning licenses in these bands might affect both revenue generated by the government and spectrum efficiency.[7] In addition, we examined the views of industry stakeholders on the implications of FCC's licensing approach in these bands on other spectrum licenses and we present this information in enclosure 1.

To address these objectives, we reviewed statutes, regulations, plans, and orders related to FCC's current common carrier licensing approach. We analyzed FCC notices on proposed changes to its common carrier licensing rules, and industry comments on FCC's approach. We reviewed academic publications, and prior GAO and Congressional Research Service reports on spectrum assignment approaches. We also analyzed the results of prior auctions of fixed point-to-point microwave licenses. We obtained data from FCC's Universal Licensing System on applications for common carrier microwave licenses submitted to, granted by, and dismissed by FCC in 2011. In addition, we analyzed data on the number of active licenses in the common carrier bands and the number of licenses canceled, terminated, or expired in 2011. Based on interviews with FCC officials for this and prior GAO reviews, as well as data testing for potential missing values, outliers, and errors, we determined that these data were sufficiently reliable for our purposes. We interviewed FCC officials as well as a judgmental sample of industry stakeholders, including common carrier license holders, industry associations, firms with related spectrum licenses, and other third-party firms.[8] We also

[3]The Department of Commerce's National Telecommunications and Information Administration (NTIA) is responsible for managing the federal government's use of the radio frequency spectrum, while FCC is responsible for regulating nonfederal spectrum use.

[4]A band is a range of frequencies in the spectrum that are used or set aside for a specific purpose (such as the 1,710–1,755 MHz band that FCC allocated for Advanced Wireless Services to support Third Generation (3G) mobile broadband and advanced-wireless services).

[5]In this report, we refer to the 11, 18, and 23 GHz bands as the common carrier bands, which include frequencies from 10,700 MHz to 11,700 MHz, from 17,700 MHz to 19,700 MHz, and from 21,200 MHz to 23,600 MHz, respectively.

[6]Pub. L. No. 112-96, § 6412(b), 126 Stat 156, 234 (Feb. 22, 2012).

[7]Our review focuses primarily on the concept of "technical efficiency"—that is, getting the most use, or "output," from a portion of spectrum, given the mission or market context of its use. Other important aspects of efficiency are also relevant in spectrum management. In particular, economic efficiency relates to whether spectrum is allocated across various uses in a way that maximizes society's welfare.

[8]In a judgmental, or nonprobability sample, a sample is selected from knowledge of the population's characteristics or from a subset of a population. For example, we identified a sample of firms to interview based on the number of common carrier licenses assigned to these firms in the 11, 18, and 23 GHz bands.

interviewed spectrum policy experts that we selected based on their expertise in spectrum policy as represented by publications, recommendations from other stakeholders, and participation in prior GAO reviews. For a full list of the industry stakeholders and experts that we interviewed, see enclosure 2. Because we selected a judgmental sample of industry stakeholders and experts, the information we obtained from these interviews cannot be generalized to all of the industry stakeholders or experts with interests and views on these topics. Information obtained from these interviews is intended to provide a sampling of views found throughout the telecommunications industry and held by spectrum policy experts.

We conducted this performance audit from April 2012 to November 2012 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Results in Brief

FCC has generally ensured the availability of licenses and encouraged the efficient use of spectrum through its various regulations. Specifically, stakeholders noted that the Commission's rules on frequency coordination, buildout requirements, and operating requirements each ensure availability of licenses and encourage efficient use of spectrum. First, FCC's requirement to coordinate new links with existing links protects incumbent licensees from interference. Under this requirement, applicants must resolve potential conflicts raised by incumbent licensees by, for example, designing links that avoid interfering with the signals of incumbent licensees. These procedures ensure availability of licenses by allowing the applicant to acquire new links and promote efficiency by increasing overall use of the spectrum. Second, FCC's buildout rule requires licensees to construct and activate links within 18 months; a licensee that fails to meet this requirement can lose its license. This promotes spectrum availability by helping to ensure that unused spectrum is again made available to other applicants. This also promotes spectrum efficiency by pushing licensees to build out their systems and begin using the spectrum in a timely manner. Third, FCC's operating rules require a licensee to cancel a license if it is not used for any 12-month period after construction, a rule that promotes availability by again helping to ensure that unused spectrum is available to other applicants and promotes efficiency by requiring use of the spectrum. Most industry stakeholders we interviewed told us that as a result of these steps, spectrum is generally available in the 11, 18, and 23 GHz bands. Similarly, FCC officials stated that based on feedback from industry stakeholders, they believe spectrum is generally available in these bands, noting that the Commission almost never rejects applications for licenses in these bands. Further, most industry stakeholders stated that FCC's approach generally encourages efficient spectrum use, although some stakeholders asserted that this licensing approach leads to the inefficient use of spectrum. However, FCC officials stated that the FCC's process encourages firms to cancel unused or underutilized licenses.

How alternative approaches to FCC's current licensing regime in these bands would affect government revenue and spectrum efficiency depends on FCC's implementation approach and the extent of spectrum availability. Some industry stakeholders stated that using competitive bidding, or auctions, could generate additional revenue for the government and encourage the efficient use of spectrum. However, the overall effect of such an approach would depend on whether spectrum is available and the number of firms assigned licenses through an auction—FCC could assign multiple licenses or a single license in a geographic

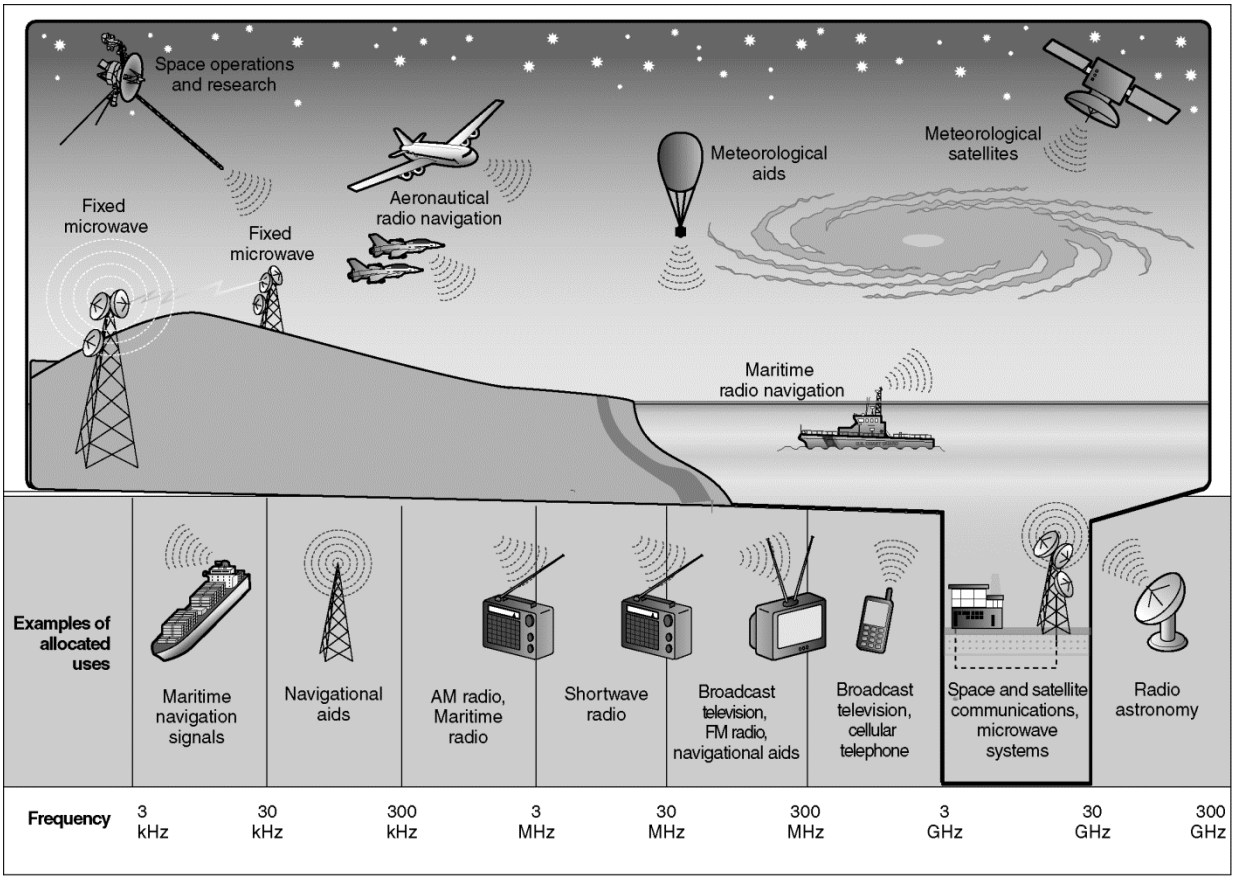
area. For example, where spectrum is generally available, experts believe that competitive bidding would not likely increase revenue or spectrum efficiency. In contrast, where spectrum is generally unavailable, experts believe that competitive bidding could encourage greater spectrum efficiency if FCC assigned licenses to multiple firms in geographic areas; firms that place the highest value on obtaining those licenses would receive the licenses in an auction. Such an approach might increase government revenue while ensuring a sufficient number of licensees exists to promote competition and establish efficient prices for links. Alternatively, FCC could use competitive bidding to assign a single license via auction; such an approach could increase government revenue, but would also diminish industry competition and thereby reduce spectrum efficiency. Spectrum policy experts stated that they believe the primary objective of auctions should be efficiency—putting the spectrum in the hands of those best able to use it—rather than focusing on revenue. Some industry stakeholders also suggested that the application of an additional spectrum fee could help FCC generate additional revenue and encourage greater spectrum efficiency. FCC is not currently authorized to assess spectrum fees for spectrum licenses,[9] but since 2001 has annually requested general authority from Congress to do so. Experts noted that the effects of a spectrum fee would depend on the amount of the fee and the availability of spectrum in the common carrier bands. In general, the application of a spectrum fee would raise the cost of a license, which would potentially increase government revenue and, where spectrum is unavailable, encourage spectrum efficiency. For example, a spectrum fee above the current regulatory and application fees could encourage those who value the spectrum less to pursue other alternatives, thus freeing the spectrum for those with who place a higher value on the use of this spectrum. Conversely, where spectrum is generally available, spectrum fees could raise some additional revenue; however, this could raise the cost of a license and encourage firms to pursue other means to transfer communications data, a pursuit that could result in less intensive use of the spectrum and, according to some stakeholders, slow broadband deployment.

Background

The radio-frequency spectrum is the part of the natural spectrum of electromagnetic radiation lying between the frequencies of 3 kilohertz (kHz) and 300 GHz. It is the medium for wireless communications and supports a vast array of commercial and governmental services. Commercial entities use spectrum to provide a variety of wireless services, including mobile voice and data, paging, broadcast television and radio, and satellite services. Federal, state, and local agencies use spectrum to fulfill a variety of government missions, such as air-traffic control, navigation, weather forecasting, and public safety. See figure 1 for examples of how spectrum is used.

[9]We use the term *spectrum fee* to refer to a premium charge for licensing spectrum in addition to existing application and regulatory fees authorized under the Communications Act, Act of June 19, 1934, ch. 652, Title I, §§ 8, 9, as amended, codified at 47 U.S.C. §§ 158, 159.

Figure 1: Examples of Allocated Spectrum Uses



Source: GAO analysis of NTIA, federal agencies, and industry information.

Historically, concern about interference or crowding among users has been a driving force in spectrum management. FCC, along with NTIA, works to minimize interference through two primary spectrum management functions—the allocation and assignment of radio spectrum. Specifically:

- Allocation involves segmenting the radio spectrum into bands of frequencies that are designated for use by particular types of radio services or classes of users. For example, the frequency bands from 88 to 108 MHz are allocated to FM radio broadcasting in the United States. In addition to allocation, spectrum managers, such as FCC and NTIA, specify service rules, which outline the technical and operating requirements for stations using specific frequency bands.

- Assignment, which occurs after spectrum has been allocated, involves providing a user, such as commercial entity or government agency, with a license or authorization to use a specific portion of spectrum. For example, FCC assigned a license for the 88.5 MHz band in Washington, D.C., to American University, for its radio station, WAMU. Generally, FCC assigns licenses for frequency bands to non-federal users such as commercial enterprises, state and local governments, and other entities; NTIA provides assignments for federal users.

FCC has used a variety of mechanisms to assign spectrum licenses, depending upon whether applications for spectrum licenses were mutually exclusive—that is, the grant of a license to one entity for a specific portion of the spectrum would preclude the grant of a license, covering the same portion of the spectrum, to any additional entities in the same location. Where licenses are not mutually exclusive, FCC has used administrative processes to assign licenses.[10] For example, FCC assigns some licenses on a first-come, first-served basis, where licenses are assigned in order of preference based upon when the license applications are submitted to FCC. For mutually exclusive applications, FCC has primarily used the following three assignment mechanisms:

- *Comparative hearings* were quasi-judicial proceedings in which competing applicants argued why they should be awarded a license, and FCC awarded licenses based on pre-established comparative criteria. FCC principally used comparative hearings from 1934 to 1984.

- *Lotteries* entailed FCC randomly selecting licensees from a pool of qualified applicants. Congress authorized FCC to use lotteries to assign mutually exclusive licenses in 1981, partially in response to the administrative burden associated with comparative hearings. FCC used lotteries from 1984 to 1993.

- *Competitive bidding*, through auctions**,** is a market-based mechanism in which FCC assigns a license to an entity based on the results of competitive bidding for specific bands of spectrum. Congress provided FCC with authority to use auctions to assign mutually exclusive licenses for certain subscriber-based wireless communications services in the Omnibus Budget Reconciliation Act of 1993.[11] FCC has used competitive bidding through auctions to assign spectrum licenses in other bands as part of its efforts to promote spectrum efficiency while enabling the government to recover a portion of the spectrum's value.[12] Where it accepts mutually exclusive applications for initial licenses, FCC is now required to assign those licenses through competitive bidding, with certain limited exceptions, such as for public safety and non commercial stations.[13]

In some frequency bands, FCC authorizes unlicensed use of spectrum—that is, users do not need to obtain a license to use the spectrum. Rather, an unlimited number of unlicensed users can share frequencies on a non-interference basis, such as with home wireless networks, cordless phones, and garage door openers. The assignment process does not apply to the use of unlicensed devices.

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[10]In choosing how to assign spectrum licenses, FCC has discretion to adopt a licensing approach that avoids mutually exclusive applications, if such an approach serves the public interest.

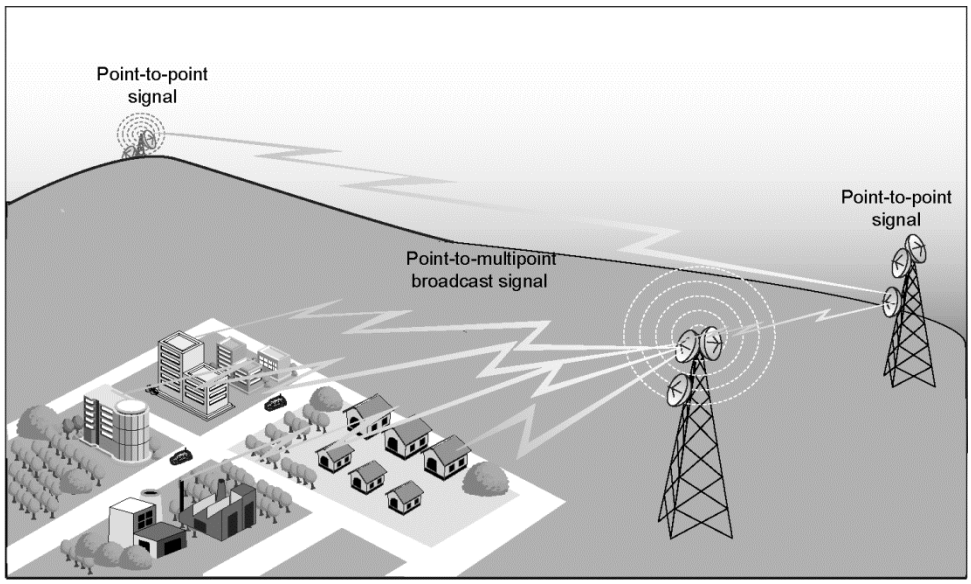
[11]Omnibus Budget Reconciliation Act of 1993, Pub. L. No. 103-66, § 6002, 107 Stat. 312, 387-392, amending the Communications Act, codified at 47 U.S.C. § 309.

[12]Specifically, as part of designing an auction, FCC is required to promote economic opportunity, competition, and the efficient and intensive use of spectrum. Communications Act, 47 U.S.C. § 309(j)(3)(B),(D). When designing competitive bidding systems, FCC is charged with ensuring that new and innovative technologies are readily accessible by avoiding excessive concentration of licenses and by disseminating licenses among a wide variety of applicants, including small businesses. 47 U.S.C. § 309(j)(3)(B). The Commission may not base a finding of public interest, convenience, and necessity on the expectation of federal revenues from the use of a system of competitive bidding nor may it prescribe regulations solely or predominantly based on such an expectation. 47 U.S.C. § 309(j)(7)(A), (B). FCC is required to seek value for the commercial use of spectrum and avoid unjustly enriching auction participants. 47 U.S.C. § 309(j)(3)(C).

[13]47 USC § 309(j)(1), (2).

FCC has specifically allocated 18 frequency bands throughout the spectrum for fixed point-to-point uses.[14] Fixed point-to-point service refers to a radio communication between two fixed points, such as between two stationary cell phone towers. To establish a link between two points, users identify a path with an unobstructed line of sight that is free of interference from other spectrum uses. At each station (each end of a link), a user must install equipment, such as radios and antennas, to transmit and receive communications. In contrast, point-to-multipoint systems transmit communications data originating from one point to multiple users. Point-to-multipoint licenses can also be used for point-to-point links. (See fig. 2.)

Figure 2: Configuration of Point-to-Point and Point-to-Multipoint Communications



Source: GAO.

Within the 11, 18, and 23 GHz bands, fixed point-to-point microwave licenses are assigned to commercial entities and state and local governments for varying purposes. Common carriers, such as wireless telephone companies, use these bands to provide communications service to the public. For example, common carriers use point-to-point links for *backhaul* connections or to connect points on the telephone network that cannot be connected using standard wireline technologies because of cost or terrain.[15] Private operators, primarily firms outside the telecommunications industry, use these bands for internal communications. For example, links in these bands may be used to operate unattended equipment; record data such as pressure, temperature, or speed of machines; or control and monitor various operations along installations like pipelines, railroads, and highways. In addition, state and local governments can use these bands for public safety purposes, such as relaying emergency calls to police and fire stations. According to FCC data, as of August 2012, over 63,000 active common carrier and other licenses exist in these bands. (See table 1.)

[14]FCC has allocated frequency bands between 930 MHz and 90 GHz for fixed point-to-point microwave uses. Both private and common carrier operations share these microwave bands.

[15]*Backhaul* is the telecommunications industry term that refers to connections between a central telecommunications network and other nodes outside the central network, such a cell phone tower.

Table 1: Active Fixed Point-To-Point Microwave Licenses in the 11, 18, and 23 GHz Bands, August 2012

License Category	11 GHz	18 GHz	23 GHz	Total
Common carrier	12,105	8,514	4,191	**24,810**
Private operational	8,285	9,177	11,715	**29,177**
Private operational - public safety service	4,529	2,650	2,009	**9,188**
Other	9	333	4	**346**
Total	**24,928**	**20,674**	**17,919**	**63,521**

Source: GAO analysis of FCC data.

Note: Each license may contain one or more point-to-point paths that transmit to different end points from the same origin station. Each path may also contain multiple frequencies.

FCC assigns common carrier fixed point-to-point licenses in the 11, 18, and 23 GHz bands on a first-come, first-served basis. Prior to submitting an application, applicants are required to coordinate with existing spectrum users.[16] As part of this process, applicants typically work with a private third party firm, known as a frequency coordinator, to communicate with existing license holders to minimize and control potential interference between existing and proposed links. Once a frequency coordinator has identified a path and frequency that does not interfere with existing users, the applicant submits an application to FCC. As part of the application for a license, which would be granted for 10 years, applicants pay a $270 processing fee as well as 10 year's worth of regulatory fees totaling $250.[17] Once assigned, a single license authorizes transmission from a single point, and because these licenses are assigned based on transmit locations, a user would need two licenses (one for each transmitter) in order to transmit from both end points in a point-to-point link.

FCC Has Taken Regulatory Steps to Help Ensure License Availability and Encourage Spectrum Efficiency

License Availability

Industry stakeholders identified a number of key regulatory actions taken by FCC and stated that these actions help ensure licenses are available in the 11, 18, and 23 GHz common carrier bands.

- *Frequency Coordination.* Several industry stakeholders we spoke with noted that the required frequency coordination provides a strong incentive for technical cooperation among licensees and protects incumbent licensees from interference.[18] Specifically, according to stakeholders, the frequency coordination process has fostered communication across all spectrum users, and resulted in a number of working groups

[16] 47 C.F.R. § 101.21(f).

[17] FCC generated approximately $2.1 million per year on average in regulatory and application fees for new and modified common carrier licenses in these bands from 2007 through 2011. FCC's regulatory fees are based on its regulatory costs, calculated and adjusted on an annual basis. For more on FCC's regulatory cost structure, see GAO, *Federal Communications Commission: Regulatory Fee Process Needs to Be Updated,* GAO-12-686 (Washington, D.C.: Aug. 10, 2012).

[18] FCC's frequency coordination rule, at 47 C.F.R. § 101.103(d), requires that an applicant, before filing its application with FCC, notify potentially affected licensees about the technical parameters of the proposed new radio system. Incumbent licensees should respond as quickly as possible and any response indicating potential interference must be provided to the applicant within 30 days.

to establish coordination practices.[19] Furthermore, communication between license holders during the coordination process helps minimize conflicts. This communication helps ensure license availability by allowing the applicant to identify potential instances of interference and proactively design a link that most efficiently avoids interfering with incumbent licensees' signals. In addition, some stakeholders noted that because many existing license holders frequently add new licenses and paths, stakeholders who operate in these bands have a strong incentive to ensure that new licenses do not preclude future uses of the spectrum.

- *Buildout Requirements.* Stakeholders stated that FCC's requirements to construct and activate links within a given time period after receiving a license help promote license availability. FCC requires that the licensee build out its system to operate the link within 18 months of a license assignment.[20] FCC's process requires licensees to demonstrate that this requirement has been met; failure to do so results in automatic termination of the license, absent a showing that it is due to causes beyond the licensee's control.[21] At that time, the spectrum previously reserved by the terminated license again becomes available to other interested parties that may apply for it. FCC publishes, on a weekly basis, details of licenses that are nearing the end of the 18-month period, thus providing information to the public about spectrum that may become available.

- *Operating Requirements.* FCC has also established procedures for termination of an unused license after a link has been constructed. For example, FCC requires that a licensee must cancel a license if it is unused for a 12-month period any time after construction is completed, or if operations are discontinued for 30 days or more because of voluntary changes made to the station by the licensee.[22] Similar to the buildout requirements, this helps to ensure availability by taking unused spectrum and making it once again available to applicants. Stakeholders also noted that the operating requirements, in conjunction with the buildout requirements, work to discourage speculative acquisition of licenses.

- *Additional Spectrum Allocation.* FCC has allocated additional spectrum in other bands for fixed point-to-point operations, thus reducing some demand for these licenses in the 11, 18, and 23 GHz bands. In an August 2011 order,[23] FCC concluded that it could expand the spectrum allocated for fixed-microwave service by permitting fixed point-to-point operations in the 7 and 13 GHz bands, in rural areas where certain television broadcast auxiliary microwave operations are not licensed.[24] Prior to this order, this spectrum was allocated for use only by television broadcast auxiliary microwave operations, though these bands are also well suited for microwave backhaul operations.

[19]Many procedures in frequency coordination were developed informally by private sector frequency coordinators. For example, FCC's rules require that coordination notices be sent to licensees operating in the same area whose existing or planned usage could be affected by a proposed license. In practice, frequency coordinators send notices to licensees that share the same band and are located within 125 miles of the licenses being proposed. Beyond this distance, interference between licensees is generally considered unlikely.

[20]47 C.F.R. § 101.63(a).

[21]47 C.F.R. §§ 101.63(c), (e); *id*. § 1.946(e).

[22]47 C.F.R. §§ 101.65(b), (a), 101.305(d).

[23]*In the Matter of Amendment of Part 101 of the Commission's Rules,* 26 FCC Rcd. 11614, 11623 (2011).

[24]Broadcast auxiliary microwave operations allow television and radio stations to transmit program material from the sites of breaking news stories to studios, to transmit program material from studios to broadcast transmitters, and to transmit programs between broadcast stations.

As a result of these actions, most industry stakeholders we spoke with—frequency coordinators, licensees, and industry associations—told us that licenses are generally available in the 11, 18, and 23 GHz bands. Frequency coordinators told us that they can nearly always find a path to support a microwave link, even in heavily congested areas. They noted that coordination failures in these bands are uncommon, and one coordinator estimated that he is unable to meet a client's need in less than one percent of requests. However, frequency coordinators and licensees do report difficulty in getting desired licenses in certain locations. For example, each frequency coordinator cited a few urban areas, such as New York City, where coordination was more challenging. Two coordinators also noted challenges in certain mountainous areas where numerous licensees depend on a single tower as a path over the mountain. Licensees also told us that frequency coordination is nearly always successful for point-to-point links within these bands. For example, seven licensees, including four nationwide broadband service providers, said they had no difficulty obtaining needed licenses. However, some licensees identified limited instances when licenses were difficult to obtain for specific locations. For example, three licensees said they have modest difficulty obtaining licenses, particularly in Washington, D.C., and Denver, Colorado, where microwave operations share spectrum with satellite operations. Most licensees said they can get the licenses they need, though they may need to use a less desirable path or frequency. All four industry associations we contacted said that FCC's approach has been successful at helping to assure spectrum availability for new license applicants.

While stakeholders report few problems acquiring licenses, the lack of available data make it difficult to quantify the availability of spectrum in these bands. First, there is no finite limit on the number of links in a given area because the potential number of links in an area depends on how links are arranged. Accordingly, engineers we spoke with told us that there is no way to know how many links can be created in a given area. Second, frequency coordinators told us they do not keep data on coordination failures because such failures are so rare. Third, FCC does not maintain data on spectrum availability in these bands. FCC does not track data on applications rejected because of a lack of available spectrum because the frequency coordination process is designed to ensure that a workable path is identified before an application is submitted to FCC. As a result, FCC officials stated that they almost never reject applications for common carrier microwave licenses because of a lack of available spectrum; rather application dismissals are generally the result of incomplete applications or unpaid application fees.[25] FCC officials stated that based on feedback from industry stakeholders, they believe that spectrum is generally available. For example, in 2012, when FCC asked for public comments on the rejection of applications for licenses in the 11, 18, and 23 GHz bands,[26] all six public respondents—three licensees, two trade associations, and a frequency coordinator—said that rejections rarely occur because of a lack of available spectrum in these bands. Four respondents did mention that adjustments might be needed in the path originally proposed.[27] In addition, FCC stated that secondary market transactions, such as the transfer of licenses between firms, are rare, a statement that suggests that most firms find that licenses are generally available through FCC.

[25]For example, in 2011, FCC rejected approximately 100 applications in nearly 2,659 applications for new common carrier licenses in these bands because of such administrative reasons. As noted previously, an application may propose more than one path for a given license.

[26]*Wireless Telecommunications Bureau Seeks Information from the Public for Report to Congress on Microwave Bands,* 27 FCC Rcd. 7062 (2012).

[27]FCC asked for information on the rejection rate of requests for common-carrier use of spectrum in the 11, 18, and 23 GHz bands. FCC specified that the rejection rate should include both applications made to the Commission and requests made to third-party coordinators.

Spectrum Efficiency

According to many licensees and other industry stakeholders, FCC's process for assigning licenses in these bands also promotes spectrum efficiency. Specifically, the stakeholders noted that many of the same regulations established by FCC to ensure availability also help promote efficient spectrum use.

- *Frequency Coordination.* According to an economics study, well-defined liability rules combined with procedures for identifying and resolving conflicts provides incentives to use spectrum efficiently.[28] FCC's coordination rules are based on the principle that existing users should be protected from harmful interference caused by later users. During the coordination process, applicants must demonstrate to existing users that they will not cause interference above a specified level. In addition, frequency coordinators may recommend that new entrants pay for interference-eliminating upgrades for incumbents' equipment. Because the process accommodates new licenses without interference to existing licenses, the addition of each new user increases the overall use of the spectrum.

- *Buildout Requirements.* As previously discussed, FCC's regulations prescribe a maximum construction period that if unmet, results in the termination of unused licenses. In addition to promoting availability, FCC's buildout requirements promote efficiency by ensuring that licensees build their links on a timely basis or allow other potential licensees the opportunity to use the spectrum.

- *Operating Requirements.* Through regulations, FCC has established operating standards for licensees in common carrier bands to encourage efficient spectrum use. As noted previously, a licensee must cancel a license if it is unused for a 12-month period any time after construction is completed, or if operations are discontinued for 30 days or more because of voluntary changes to the station. In addition to these requirements, FCC has also established equipment capacity requirements for common carrier bands. For example, in each of the common carrier bands, new licensees are required to comply with minimum equipment capacities to ensure that licensees use their acquired spectrum.[29] These requirements help encourage the intensive use of spectrum in these bands.

Nevertheless, some industry stakeholders stated that FCC rules may not fully encourage efficient use of common carrier spectrum. Although FCC allows for the cancellation of a whole license at no charge and returns the unused portion of the original regulatory fee, licensees are required to pay an application fee to cancel an unused path on an active license. Furthermore, stakeholders said that FCC does not actively monitor compliance with its rules even though the operating standards regulate minimum capacity and non-use to promote efficiency. For example, FCC requires licensees to turn in unused licenses, but relies on licensees to self-report compliance with this requirement. FCC typically only investigates compliance with its rules when other industry stakeholders notify the Commission about possible non-compliance. As a result, some industry stakeholders speculated that there may be some portion of these bands in which spectrum is licensed but unused.

[28]Carson E. Agnew and Richard G. Gould, "Frequency Coordination and Spectrum Economics," *Research in Law and Economics*, vol. 9 (1986): 167-184.

[29]FCC created minimum capacity requirements for new digital equipment placed in service after 2005. 47 C.F.R. § 101.41(a)(1)(ii).

FCC officials acknowledged that FCC relies mainly on licensee self-reporting to ensure compliance with many of these regulatory requirements. However, they stated that because of the resources required to monitor compliance with even a sample of the 64,000 licenses in operation, the Commission does not independently verify whether licensees are in compliance with construction and operating requirements. Furthermore, FCC officials noted that from a technical perspective, it is difficult to monitor the energy emitted from a microwave station. Nevertheless, FCC officials stated that FCC's process generally encourages firms to cancel unused or underutilized licenses. According to FCC, licensees voluntarily canceled and returned 474 common carrier licenses in the 11, 18, and 23 GHz bands in 2011. In addition, FCC terminated 27 common carrier licenses in these bands for failure to meet regulatory requirements in 2011, including the buildout and operating requirements. By comparison, FCC received over 2,600 applications for new, similar licenses in these bands during the same period.

The Effect of Alternative Assignment Approaches on Revenue and Spectrum Efficiency Would Depend upon FCC's Implementation Approach and Spectrum Availability

Competitive Bidding

Some telecommunications companies have suggested that using competitive bidding (auctions) could help encourage spectrum efficiency in the common carrier microwave bands and increase the revenue generated from the assignment of licenses. Experts and industry participants stated that assigning individual point-to-point licenses through an auction would be impractical because of the nearly infinite number of links that could be created in this spectrum and would generate limited interest from firms. Experts stated that competitive bidding, if adopted by FCC, should instead assign area-wide licenses exclusive to a geographic or metropolitan area. FCC has previously used auctions to assign some point-to-point and point-to-multipoint licenses on an exclusive geographic, area-wide basis. Applied to the common carrier bands, the licensee could use the spectrum authorized by the area-wide license to lease links to other common carriers. In this scenario, the licensee would thus perform the frequency coordination and assignment functions currently performed by frequency coordinators and FCC, respectively. However, the results of these types of auctions have varied. For example, in 2000, FCC made 2,450 point-to-point licenses in the 39 GHz band available for purchase at auction. The auction sold nearly 90 percent of the licenses, raising $410 million for the U.S. Treasury. However, in 2004, FCC only sold 7 of the 880 point-to-point and point-to-multipoint licenses available in the 24 GHz band, raising about $216,000. Industry stakeholders attributed the outcome of the 2004 auction to economic conditions within the telecommunications industry, among other things.

FCC could use competitive bidding to assign multiple area-wide licenses for a metropolitan area in each of the common carrier bands, but experts stated that the effects of such an approach would depend on the availability of spectrum in the bands. In structuring the auction, FCC would need to determine how many firms to license in a given band and geographic area; FCC would want to ensure a sufficient number of licensees to promote competition and efficient prices for the resulting links. The auction winners could then use the licenses to lease links under these licenses to other firms similar to how FCC currently assigns point-to-point licenses to firms, or use the licenses for their own business purposes. However, the ultimate outcome of the auction would depend on whether spectrum for these licenses was available. As previously discussed, few instances of scarcity exist in the common carrier bands. Accordingly, in an environment where spectrum was available, experts stated that such an approach would be unlikely to increase spectrum efficiency or government revenue. However,

if there was a spectrum shortage in these bands, competitive bidding could provide a means to assign spectrum to users who place the highest value on that spectrum and may generate additional revenue.

Alternatively, FCC could use competitive bidding to assign a single exclusive, area-wide license via auction; such an approach could increase government revenue, but would also reduce spectrum efficiency as a result of diminished industry competition. For example, FCC could design an auction that results in a single, exclusive license for each metropolitan area for the three common carrier bands. Potential licensees would submit bids based on their expected ability to charge higher prices as a result of being the sole supplier of common carrier links in their awarded geographic area. However, such an approach would result in a loss of spectrum efficiency, since the higher prices created by the establishment of a sole provider in each band would result in less intensive use of the spectrum. Spectrum policy experts we spoke with opposed the use of this approach because such a policy might artificially create spectrum shortages and reduce spectrum efficiency.

Regardless of any FCC competitive bidding approach, the Commission would need to determine how current license holders would be affected. FCC could encourage existing point-to-point operators to migrate to other frequencies allocated for point-to-point users. For example, when FCC relocated spectrum from fixed point-to-point uses in the 2.1 GHz bands in 2006, FCC required the new license holders to negotiate with existing license holders to help them relocate to other sections of the radio-frequency spectrum. These negotiations were designed to determine relocation costs. As part of these negotiations, new license holders were generally expected to pay the cost of relocating existing users, which would include replacing systems as needed, completing frequency coordination for the new links, and covering any increased operating costs resulting from the use of a different frequency. We have previously reported that FCC's re-assignment process can be lengthy.[30] In the case of the 2.1 GHz bands, these efforts began in 2006 and are still under way. Furthermore, FCC officials stated that other bands may not be able to accommodate the existing licensees in the 11, 18, and 23 GHz bands. Alternatively, some industry stakeholders suggested that existing license holders could work with auction winners to retain their licenses in these bands once an existing licensee's 10-year license term has concluded. Under such a scenario, existing licensees would decide at the end of their license term either to lease spectrum from auction winners, or terminate their licenses and relocate to another frequency. Some industry stakeholders also stated that FCC might consider protecting the rights of existing license holders and only auction unused spectrum in these bands.

Experts and industry stakeholders provided a range of views on the use of competitive bidding to assign licenses in these bands. Experts stated that the primary objective of these auctions should be increasing efficiency—putting the spectrum in the hands of those best able to use it—rather than maximizing revenue. Some experts pointed out that auctions have the potential to raise a lot of money for the government and assign spectrum quickly, but auctions do not always promote efficient spectrum use. Furthermore, as previously discussed, experts stated that unless spectrum is unavailable, competitive bidding is unlikely to produce any additional revenue or spectrum efficiency. Many common carrier licensees as well as industry stakeholders we spoke with noted that the reduced competition that might come from the use of an auction could result in a variety of negative outcomes, though many of these effects would be limited to areas where shortages exist. They stated that an auction could allow a few

[30]GAO, *Commercial Spectrum: Plans and Actions to Meet Future Needs, Including Continued Use of Auctions*, GAO-12-118 (Washington, D.C.: Nov. 23, 2011).

firms to control significant amounts of both wireless licenses and wireline alternatives. In addition, where shortages exist, an auction could increase the cost of obtaining a microwave link. Specifically, common carrier licensees and stakeholders said that winning firms may try to raise prices for firms without spectrum licenses by reducing the number of available links. Firms speculated that as the cost of obtaining a link increased, spectrum efficiency would be reduced thus slowing broadband deployment in these bands. Moreover, according to the firms, competitive bidding could encourage speculative acquisition of microwave licenses, prompting some firms to buy up spectrum where shortages exist and resell it at a profit, rather than use it for their own needs. However, as previously discussed, spectrum is generally available in these bands, and thus the potential for such speculative actions appears limited.

Spectrum Fees

FCC has argued that licenses that limit spectrum to specific uses, such as the licenses in the common carrier bands, do not provide market signals about new uses with potentially higher value. According to the National Broadband Plan, additional spectrum fees, beyond FCC's regulatory fee, might help certain licensees consider the value of their spectrum by comparing their valuation of the spectrum to the amount of the spectrum fee.[31] Thus, the amount of the fee should reflect the best feasible alternative use of that spectrum, also known as the opportunity cost of the spectrum. According to the plan, spectrum fees may help to free spectrum for new uses such as broadband services, since licensees that use spectrum inefficiently may reduce their holdings as the cost of the fee increases. However, FCC is not currently authorized to assess spectrum fees on licenses; it has annually requested general authority to do so from Congress since 2001.

Some industry stakeholders have identified spectrum fees as an approach that might help FCC generate additional revenue and encourage greater spectrum efficiency in the common carrier bands. For example, some stakeholders have stated that FCC's current licensing approach does not capture the value of the spectrum assigned to users; instead, FCC's current fee structure is designed to recover the cost of processing applications and administering the licensing regime. A spectrum fee approach might involve, for example, an additional fee assessed per license based on the amount of spectrum used by a licensee, or a fee assessed on all common carrier licenses in a given geographic area.

The effects of a spectrum fee applied to licenses in the common carrier bands would depend on the availability of spectrum and the extent to which increases in the cost of a license affect potential licensees. Spectrum policy experts stated that the amount of the spectrum fee should be set to encourage efficiency, rather than maximize revenue, since the latter approach could result in unused spectrum and would therefore be inefficient. Where spectrum is unavailable or scarce, a spectrum fee could potentially increase government revenue and encourage spectrum efficiency. Specifically, a spectrum fee above the current regulatory and application fees could encourage those that value the spectrum less to pursue other alternatives, thus freeing the spectrum for those with who place a higher value on the use of this spectrum. For example, some experts suggested that if FCC applied a spectrum fee in select urban areas when demand exceeds supply, it could generate additional revenue and encourage links to be acquired by those who value them the most. However, if spectrum is available, a spectrum fee has the potential to raise additional revenue, but might be offset by a decrease in the use of spectrum of these bands. For example, users that place a high value on use of this spectrum will continue to use the spectrum and would be willing to pay more than the current fees, thus

[31]FCC, *Connecting America: The National Broadband Plan* (Washington, D.C.: Mar. 16, 2010), 82-83.

potentially increasing government revenue. However, once the fee exceeds a user's value for the license, the users may decide to pursue other spectrum or wireline alternatives, thus reducing the use of this spectrum. Furthermore, both changes to government revenue and spectrum efficiency would depend on whether the increase in price motivates common carriers to use alternatives to these bands. For example, raising the cost of a license in the common carrier bands could encourage firms to pursue other means to transfer communications data. According to some industry stakeholders, a spectrum fee could increase the demand on other already congested data transmission methods, including other spectrum licenses, fiber optic lines, or other services. In addition, stakeholders suggested that spectrum fees could raise the cost of broadband, thus reducing its adoption.

Concluding Observations

FCC's current approach to assigning common carrier licenses in the 11, 18, and 23 GHz bands has generally ensured licenses in these bands are available and encouraged spectrum efficiency. While most stakeholders noted that spectrum is currently generally available in these bands, no data exists to definitively determine how much spectrum is available in these bands, and some stakeholders have experienced difficulty obtaining licenses in some urban areas. Without definitive information on spectrum availability in these bands, it is unclear whether there is a need for other approaches, such as the use of competitive bidding or the application of spectrum fees, to generate more revenue for the government and increase spectrum efficiency. Moreover, it may be challenging to design and implement approaches that would successfully increase both revenue and spectrum efficiency. However, as the demand for spectrum is not static, and if spectrum becomes less available in the future, these alternative assignment approaches might become preferable to the current approach when assigning licenses in these bands.

Agency Comments

We provided a draft of this report to FCC for comment. FCC provided technical comments, which we incorporated where appropriate.

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We are sending copies of this report to the Chairman of the Federal Communications Commission, and the appropriate congressional committees. In addition, this report will be available at no charge on the GAO website at http://www.gao.gov.

If you have any questions about this report, please contact me at (202) 512-2834 or goldsteinm@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in enclosure 3.

Mark L. Goldstein
Director
Physical Infrastructure Issues

Views on the Implications of FCC's Common Carrier Licensing Process on Related Spectrum

The Federal Communications Commission (FCC) has assigned some exclusive use, geographically-based licenses in bands outside the 11, 18, and 23 gigahertz (GHz) common carrier bands and some stakeholders have suggested that these licenses could serve as alternatives to the use of spectrum in the common carrier bands. FCC assigned exclusive, geographic licenses in these bands (referred to as *related spectrum*) through auctions that occurred from 1998 to 2000, with winning bidders receiving the exclusive right to operate in an assigned geographic area and frequency range. Stakeholders identified point-to-multipoint licenses in the Local Multipoint Distribution Service (LMDS) bands, which include frequencies from 27.5 GHz through 31.3 GHz, as well as licenses in the 39 GHz band as potential alternatives to common carrier licenses in the 11, 18, and 23 GHz bands.

Some firms holding geographic point-to-multipoint licenses in the related spectrum have argued that FCC's process for assigning licenses in the 11, 18, and 23 GHz bands discourages the efficient use of the LMDS and 39 GHz bands. Owners of these area-wide licenses in related bands said that FCC's licensing process undercuts their ability to compete in the backhaul market and to lease point-to-point links in their spectrum to other firms. These firms stated that the private sector considers licenses in the 11, 18, and 23 GHz as similar to licenses in the LMDS and 39 GHz bands, and that this creates downward pressure on their prices to align with the price for obtaining a point-to-point license in the common carrier bands from FCC. The firms suggested that by setting a low price for common carrier spectrum, FCC encourages the overuse of common carrier spectrum, and the underutilization of spectrum licensed for exclusive use in other bands, such as in the LMDS and 39 GHz bands. Specifically, they further suggested that the current FCC application and regulatory fees for common carrier licenses force the licensees in related bands to price their spectrum at a discount (from its value and utility as reflected by the price originally paid at auction) in order to compete for licensees. For example, one owner of related spectrum licenses said it has leased services in these related bands at rates below what it considers the value of the spectrum in order to compete with common carrier licenses. Accordingly, some of the firms holding related spectrum licenses suggested that FCC should consider alternative assignment approaches for licensing common carrier spectrum, in order to promote parity between the price of their licenses and that of common carrier licenses in the 11, 18, and 23 GHz bands.

Experts disagreed with the suggestion that FCC should promote parity between the licenses in the LMDS and 39 GHz bands and the common carrier licenses in the 11, 18, and 23 GHz bands. Some experts noted that raising the price of a common carrier license could discourage use of these bands, thus reducing efficient use of the common carrier spectrum. Furthermore, some experts questioned the idea that FCC should seek to promote parity between the common carrier licenses and the point-to-multipoint licenses as a policy goal. For example, FCC's point-to-point licensing process was in place at the time of the point-to-multipoint auctions so bidders had the opportunity to factor any potential effects of FCC's common carrier licensing process on the value of the exclusive licenses into their bid prices. In addition, this spectrum was not, at that time, considered to be an alternative to common carrier licenses, and it has only been in the last few years that the use of this spectrum as a potential alternative has become practical.

Furthermore, key differences between these exclusive spectrum licenses and the common carrier licenses exist, raising doubts about the whether the value of a license in the LMDS and 39 GHz bands is comparable to the value of a common carrier license. First, FCC operational

rules generally provide significant flexibility to licensees operating in both the LMDS and 39 GHz bands. For example, licensees are permitted to offer point-to-multipoint and point-to-point services. Licensees in the 11, 18, and 23 GHz bands can only use their licenses for specific point-to-point applications. Second, licensees in the LMDS and 39 GHz bands also have exclusive use of the spectrum in the specific area covered by their licenses. Spectrum in the 11, 18, and 23 GHz bands is licensed based on transmit locations and paths, so FCC can assign new licenses to multiple firms in a given geographic area. Third, the physical properties of the exclusive-use bands may differ from the 11, 18, and 23 GHz bands. The path length supported by related spectrum is short, compared to a common carrier license path. For example, an LMDS path can be no greater than 5 miles while an 11 GHz band path can be over 20 miles long. In fact, licensees in the LMDS and 39 GHz bands stated that licenses in these bands may offer advantages over conventional common carrier licenses. For example, licensees noted that they can provide faster availability to users because the frequencies in these bands can be coordinated more quickly than in the common carrier frequencies, which are coordinated through FCC's licensing approach.

Some common carrier licensees said they do not consider these particular exclusive licenses as a viable alternative for their point-to-point backhaul needs, but others see these licenses as having potential to help meet the growing demand for *backhaul*.[32] Some common carrier licensees cited disadvantages of related spectrum that included its short range; the high cost of equipment, as compared to the readily available equipment for 11, 18, and 23 GHz licenses; and the higher cost of leasing spectrum for point-to-point service from the licenses compared to the cost of applying for an FCC license. However, some other common carrier licensees stated that spectrum in the LMDS and 39 GHz bands has a number of advantages that make it a potential alternative to common carrier spectrum, including its greater availability (compared to common carrier spectrum) and recent improvements in available equipment. For example, one licensee told us that it prefers to utilize its existing LMDS licenses for backhaul because this band is particularly useful for establishing short links in dense urban areas.

[32]*Backhaul* is the telecommunications industry term that refers to connections between a central telecommunications network and other nodes outside the central network, such a cell phone tower.

Enclosure II

List of Stakeholders and Experts GAO Contacted For Views on FCC Licensing Approaches

Table 2: Non-Government Industry Stakeholders and Experts Interviewed

Industry Stakeholders
AT&T
Bel Air Internet
Clearwire Corp.
Comsearch
CTIA – The Wireless Association
Exalt Communications
Fiber Tower
Fixed Wireless Communications Coalition
IDT Spectrum
MetroPCS
Micronet Communications
National Spectrum Management Association
Radyn, Inc.
Sprint/Nextel
Telecom Transport Management, Inc.
T-Mobile
Verizon Wireless
Widelity, Inc.
XC Networks
XO Communications

Experts
Coleman Bazelon, The Brattle Group
Michael Calabrese, New America Foundation
Thomas Hazlett, George Mason University School of Law
Benjamin Lennett, New America Foundation
Paul Milgrom, Stanford University
Gregory Rosston, Stanford Institute for Economic Policy Research

Source: GAO.

GAO Contact and Staff Acknowledgments

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